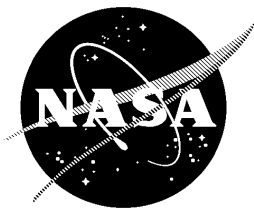


**New Millennium Program
Earth Orbiter-1 (EO-1)
Ground Segment Level II Requirements**



National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

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Revision	Description	Date	Approval
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Appendix A. NMP EO-1 Ground Segment Level II Requirements

Abbreviations and Acronyms

Section 1. Introduction

This document contains the New Millennium Program (NMP)/Earth Orbiter-1 (EO-1) Ground Segment Level II requirements. The EO-1 Ground Segment Level II requirements specify and define requirements at the ground segment subsystem level. These requirements address ground segment subsystem level functional and performance specifications as well as interface requirements to spacecraft and technology.

The EO-1 mission requirement definition is accomplished in three levels. The Level I requirements define the EO-1 mission objectives and products. The Level II requirements identify and allocate appropriate requirements to mission segments (Technology, Spacecraft, Ground Segment). The Level II requirements are top-level requirements for each mission segment. The Level III requirements are the lowest level requirements for the mission. The Level III requirements are directly implemented at the hardware and software levels. The Level III requirements are traced to Level II and then to Level I. All Level III requirements have either parent requirements in Level II and/or Level I, or have justification for their orphan status.

Section 2. Requirement Organization

Requirements are organized and identified by Requirement ID, Requirement Type, Requirement Title, and Requirement Statement. The Requirement ID is a numbering system where each requirement is assigned a unique number. This number is used in tracing a requirement from parent to child and vice versa. The Requirement Type is an indicator for the type of requirement. A detailed description of the Requirement Types is provided in the Section 3. The Requirement Title is a title for the requirement. The Requirement Statement provides the required action or activity. There is only one required action or activity per Requirement Statement.

The Level II requirements for the Ground Segment of the EO-1 are given in Appendix A.

Section 3. Requirement Type Definitions

The requirement types are defined below.

H (Hierarchical) Requirement—A requirement that is not directly verifiable but provides structure to a set of requirements. A hierarchical requirement must be verified “through validation.” This means that the child requirements must be validated to define the success of the parent, and the child requirements must be verifiable.

NOTE: Child requirements may themselves be hierarchical.

FC (Functional Category)—A hierarchical requirement that is the parent of a set of child requirements. Generally the functional category may be viewed as a container of a set of requirements that are “alike” in some manner, such as

- a. Have similar functionality
- b. Have the same functionality applied to different elements
- c. Are verified as a group

F (Functional) Requirement—A requirement that is a child requirement to a functional category. A functional requirement is the parent requirement to performance requirements. Functional requirements specify functions of the system, subsystem, instrument, or component. Functional requirements must be verifiable by test, analysis, or inspection.

P (Performance) Requirement—A requirement that is a child requirement to a functional requirement. The performance requirements are directly verifiable, and each performance level is verified. The performance requirements specify discrete performance levels of the system, subsystem, instrument, and/or component. The verification methods for performance requirements are test, analysis, and/or inspection.

Section 4. Requirement Verification

The requirements shall be verified using methods accepted by the EO-1 mission management. The acceptable verification methods include testing, analyses, and/or inspection. Positive verification for each requirement shall be provided. A requirement shall be verified either directly or indirectly. An example of an indirect verification would be such that a Level I requirement is traced to Level II and then to Level III, where a direct verification of the Level III requirement is accomplished. In this case, the Level I and II requirements are verified indirectly, and the Level III requirement is verified directly. This is an acceptable verification approach.

Section 5. Requirements Verification Matrix

The requirements verification matrix shall be developed. The matrix shall identify the requirement, verification method, verification acceptable criteria, verification results, and date of verification.

Section 6. EO-1 System Validation

The requirements verification matrix, along with requirements tracing to either parent or child, shall be the basis for the EO-1 system validation.

Appendix A. NMP EO-1 Ground Segment Level II Requirements

Requirement ID	Requirement Type	Requirement Title	Requirement Statement
01	H	NMP/EO-1 Ground System (EGS) Level II Requirements	This document defines Level II requirements for the NMP EGS.
01.01	H	NMP-EO-1 Mission Operations Center (MOC)	The NMP EO-1 MOC shall provide the capability to implement all phases (prelaunch through disposal) of the EO-1 mission operations.
		Mission Planning	The MOC shall plan all satellite activities.
01.01.01	FC	MOC	The MOC shall operate and control the EO-1 spacecraft, manage commands, schedule ground stations, trend telemetry, and monitor spacecraft health and safety.
01.01.01.02	F	Command Management	Real-time and stored command loads shall be created and uploaded.
01.01.01.03	F	Telemetry Management	The EGS shall be capable of receiving housekeeping and science telemetry, from the ground stations, at least twice a day.
01.01.01.04	F	Maintain Observatory Health and Safety	Observatory health and safety shall be monitored and analyzed, and corrective commands generated.
01.01.02	FC	Data Processing System (DPS)	The DPS shall receive and process all science and associated housekeeping data to create input files for the Science Validation Facility (SVF) (i.e., ALI, AC).
01.01.02.01	F	Data Reformat	The PDS shall reformat data as required by the SVF.
01.01.02.02	F	Data Transfer	The reformatted data shall be transferred to the SVF and the transfer verified.
			The DPS shall provide Level 0 data to the SVF within 12 hours of completed Level 0 data processing.
			The DPS shall assess and report on the quality of received science and housekeeping data
			The DPS shall assess and report on the quality of processed Level 0 data.
			The DPS shall provide metadata associated with processed Level 0 data, to facilitate
01.01.03	FC	Flight Dynamics System (FDS)	The FDS shall ensure that spacecraft orbit is maintained and shall validate attitude and orbit.
01.01.03.01	F	Orbit Maintenance	The FDS shall ensure that the EO-1 spacecraft maintains an orbit with high precision relative to Landsat 7. Descending node is 1 minute behind Landsat 7 and ± 3 km cross-track.
01.01.03.02	F	GPS Validation	The FDS shall provide validation of the onboard GPS orbit determination.

Requirement ID	Requirement Type	Requirement Title	Requirement Statement
01.01.03.03	F	Attitude Validation	The FDS shall provide attitude validation and calibration information for the onboard ACS.
01.01.03.04	F	Ground Station View Periods and Pointing Vectors	The FDS shall generate ground station view periods and pointing vectors.
01.01.03.05	F	Spacecraft Maneuver Commands	The FDS shall generate maneuver command engineering inputs (reboost, inclination adjust, science collection, lunar and solar calibration).
01.01.03.06	F	Spacecraft Antenna Pointing	The FDS shall generate spacecraft antenna pointing inputs.
01.01.03.07	F	Ephemeris File Generation	The FDS shall be capable of generating an ephemeris file for uplink.
01.02	H	NMP/EO-1 Ground Station Network and Ground Communication	The Ground Station Network shall be established to support all phases (prelaunch through disposal) of the EO-1 mission.
01.02.01	FC	Ground Stations	The EO-1 mission shall be supported with both primary and backup ground stations.
01.02.01.01	F	Primary Ground Station	The primary ground station shall be the automated orbital tracking station at Spitzbergen.
01.02.01.02	F	Backup Ground Stations	The backup ground stations during L&EO shall be the automated orbital tracking stations at Poker Flats and Wallops.
01.02.01.03	F	McMurdo Ground Station	McMurdo shall provide backup ground station support during L&EO and maneuvers during the mission.
01.02.01.04	F	TDRSS	TDRSS shall provide downlink telemetry support during L&EO.
01.02.02	FC	Ground Station Functions	Ground stations shall provide the functions listed below.
01.02.02.01	F	Telemetry	The ground stations shall be capable of receiving both X-band and S-band telemetry.
01.02.02.02	F	Commands	Commands shall be throughput to the spacecraft upon receipt at the ground station.
01.02.02.03	F	Tracking 2-Way Data and Angles Data	Shall provide 2-way doppler and angle support.
01.02.02.04	F	Data Recording and Processing	The ground stations shall be capable of recording on site for transfer to the MOC.
01.02.02.05	F	Data Transfer	Ground stations shall transfer telemetry data electronically, upon receipt, and science data via storage media to the MOC.
01.03	H	NMP EO-1 Mission Science Office	The NMP EO-1 Mission Science Office shall support all phases (prelaunch testing through disposal) of the EO-1 mission.
01.03.01	FC	Mission Planning	The Mission Science Office shall support the MOC in mission planning.
01.03.01.01	F	Science Plans	The Mission Science Office shall plan image taking based on interaction with the Landsat 7 science team and the EO-1 science team.
01.03.01.02	F	Spacecraft Command Generation	The Mission Science Office shall provide agreed-to science plans as needed for command generation to the MOC.

Requirement ID	Requirement Type	Requirement Title	Requirement Statement
01.03.01.03	F		The Mission Science Office shall plan and assess periodic lunar and solar scanning calibration with a goal of 5% absolute radiometric accuracy.
01.03.01.04	F		The Mission Science Office shall gather a representative sample of multispectral terrain images that capture the seasonal variations encompassing one entire growing season (March through October) in the Northern Hemisphere.
01.03.01.05	F		The Mission Science Office shall perform a minimum of 200 paired-scene comparisons with Landsat 7 (ETM+) comparing the spectral reflectance of known surface features with the cross-track pointing capability of the spacecraft.
01.03.01.06	F		The Mission Science Office shall assess the optical performance of the ALI wide field, Silicon Carbide Optics.
01.03.01.07	F		The Mission Science Office shall assess the use of the AC data to determine atmospheric water vapor, aerosols, and clouds.
01.03.01.08	F		The Mission Science Office shall assess the use of AC data from cloud-free scenes to correct paired Landsat 7 and ALI images for the effects of atmospheric extinction.
01.03.02	FC	SVF	The SVF shall receive data from the DPS.
01.03.02.01	F	DPS Files	The SVF shall receive, process, and archive science and housekeeping Level 0 files from the DPS.
01.03.02.02	F	Scene Assessment	The SVF shall assess the quality of imager scenes.
01.03.02.03	F	Scene Processing	The SVF shall generate Level 1 EO-1 imager scenes as required (i.e., ALI, AC).
01.03.02.04	F	Scene Distributing	The SVF shall distribute science data to EO-1 investigators.
01.03.02.05	F	Data Archiving	The SVF shall archive science data.
		Science Data Quantity	The SVF shall be capable of processing up to 800 scenes per year, 20 per week.
01.03.02.06	F	Instrument Alignment	The SVF shall with the FDS refine instrument to ACS alignment estimate.

Abbreviations and Acronyms

AC	Atmospheric Corrector
ACS	Attitude Control System
ALI	Advanced Land Imager
DPS	Data Processing System
EGS	EO-1 Ground System
EO-1	Earth Orbiter-1
ETM+	Enhanced Thematic Mapper Plus
F	functional requirement
FC	functional category
FDS	Flight Dynamics System
GPS	
H	hierarchical requirement
km	kilometer
L&EO	launch and early orbit
MOC	Mission Operations Center
NMP	New Millennium Program
P	performance requirement
SVF	Science Validation Facility
TDRSS	Tracking and Data Relay Satellite System